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THE DEVELOPMENT OF FLOUNDERS.

BY ALEXANDER AGASSIZ.

THE manner in which the eyes of a flounder become placed on one side of the body has formed a fertile subject for theories. I do not at present propose to discuss the explanations given to account for the facts, but merely to state the results of observations made while studying the development of a number of species of flounders common to our coasts. In the case of five species the passage of the eye from one side to the other is not, as urged by Malm, a simple tendency of the eye of the "blind side" (the side upon which the flounder lies) to turn towards the light and thus carry the surrounding parts of the head with it. The eye placed on the blind side actually travels from its original place (symmetrical with the eye of the opposite side) frontwards and upwards on the blind side, resorbing the tissues in its way, new tissues forming behind; there follows this movement of translation a certain amount of torsion of the whole of the frontal part of the head, which commences only after the eye of the blind side has nearly reached the upper edge of that side, quite a distance in advance of its primitive position. This torsion of course takes place most readily, occurring as it does during a stage when the whole bony fabric of the skull is still cartilaginous, and it is the torsion which ends in bringing the eye to the opposite side. In four of these species of flounders the dorsal fin did not at that young stage extend to the posterior edge of the orbit of the eye coming from the blind side.

In another species, after the eye had thus by the same process of translation and of torsion been brought from the one side to the other, the dorsal fin gradually extended beyond the anterior edge of the orbit of this eye. This young flounder thus soon presented a stage in which the eye from the blind side appeared

to have passed through the head between the frontal bone and the base of the anterior rays of the dorsal fin. As I had, however, followed the whole development in living specimens, I knew from actual observation that the mode of transfer of the right eye had been identical with that of the preceding species. These observations thus far confirm in the main Malm's explanation of the development of young symmetrical flounders into the well-known older stages. To my great astonishment, therefore, I captured one day a number of flounders (about an inch in length) closely allied to the *Plagusia* of Steenstrup, the so-called *Bascania* of Schiödte; they were so perfectly transparent that they seemed the merest film on the bottom of the glass vessel in which they were kept. They were still entirely symmetrical, the eyes well removed from the snout, with a dorsal fin extending almost to the nostril, far in advance of the anterior edge of the orbits of the eyes. They were of course at once set down (from their size) as belonging to a species of flounder in which the eyes probably remained always symmetrical, and I prepared to watch its future development. It was therefore with considerable interest that I noticed, after a few days, that one eye, the right, moved its place somewhat towards the upper part of the body, so that when the young fish was laid on its side, the upper half of the right eye could be plainly seen, through the perfectly transparent body, to project above the left eye. The right eye (as is the case with the eyes of all flounders), being capable of very extensive vertical movements, through an arc of nearly 180° , could thus readily turn to look through the body, above the left eye, and see what was passing on the left side, the right eye being of course useless on its own side as long as the fish lay on its side. I may mention here that this young flounder, until long after the right eye came out on the left side, continued frequently to swim vertically, and that for a considerable length of time. This slight upward tendency of the right eye was continued in connection with a motion of translation towards the anterior part of the head till the eye, when seen through the body from the left side, was entirely clear of the left eye, and was thus placed somewhat in advance and above it, but still entirely in the rear of the base of the dorsal fin extending to the end of the snout. What was my astonishment on the following day, on turning over the young flounder on its left side, to find that the right eye had actually sunk into the tissues of the head, penetrating into the space between the base of the dorsal fin and the frontal bone, to such an

extent that the tissues adjoining the orbit had slowly closed over a part of the eye, leaving only a small elliptical opening, smaller than the pupil, through which the right eye could look when the fish was swimming vertically. While the young flounder lay on its side, the right eye was constantly used in looking through the body, and could evidently see extremely well all that took place on the left side. On the following day the eye had pushed its way still farther through, so that a small opening now appeared opposite it, on the left side, through which the right eye could now see directly, the original opening on the right side being almost entirely closed. Soon after, this new opening on the left increased gradually in size, the right eye pushing its way more and more to the surface and finally looking outward on the left side with as much freedom as the eye originally on the left; the opening of the right side having permanently closed. I have thus in one and the same specimen been able to follow the passage of the eye from the right side to the left through the integuments of the head, between the base of the dorsal fin and the frontal bone.

This observation leads to somewhat different conclusions from those of Steenstrup, who thought he could prove (from an examination of alcoholic specimens) that the eye from the right side passed under the frontal bone. This is evidently not the case here, the eye passing round it, there being only a very slight torsion of the frontal in this young stage. Although at first glance this appears so radically a different method of transfer of the eye from the one described above, yet if the dorsal fin had not extended beyond the posterior edge of the right orbit the process would have been the same, as is readily seen. I hope soon to give full details, with illustrations, of the process of transfer of the eye in its different stages, in a paper I am preparing on the young stages of a few of our bony marine fishes.

But while I have thus been able to trace step by step in living specimens the transfer of the eye from one side to the other, I can give no explanation of the cause which compels flounders to lie on their side. The explanations usually given are not satisfactory. For the great depth of the body, the position of the dorsal and of the ventral fins, the undulating mode of swimming, — all these are so many causes specially adapted to enable them to swim in a vertical position. In fact, they always swim vertically in young stages, when their capacity for vertical support is infinitely less than when they commence to lie on one side.

The rapidity with which the young flounders adapt themselves to the color of the ground upon which they are placed is marvelous. In one of the species the red, yellow, and black pigment cells were brought into the proper combination and prominence with such rapidity that it seemed hardly credible that the same fish could assume such different hues in so short a time. The size and number of these pigment cells, however, readily account for all this.

The young of this transparent flounder do not invariably lie down on the right side; it seems almost a matter of chance which side they choose. Out of fifteen specimens eight lay down on the left and all died without being able to accomplish any part of the transfer of the left eye to the right side, although they lived quite long enough for the other seven, which turned down on the right side, to accomplish the transfer, or nearly so. This incapacity may account for the rarity of sinistral forms of flounders, and *vice versa*. In the other species mentioned above, all the young I have had occasion to keep alive turned down on the proper side for a successful transfer of the eye. I may also mention here that at a certain stage of growth of our *Otenolabrus* the young show a very decided tendency to lean on the right side. This is even seen in fully grown specimens, in the peculiar slanting position often taken by individuals when they approach an obstacle.

THE FORMER RANGE OF SOME NEW ENGLAND CARNIVOROUS MAMMALS.

BY J. A. ALLEN.

THE geographical range of the larger mammals of New England is well known to have been much more extended formerly than it is at present. Not only have most of the larger species greatly decreased in numbers throughout the more thickly settled portions of the Eastern States, but not a few have become extirpated over regions where they were formerly abundant. This restriction of range and numerical decrease are obviously due to man's agency. Most of the carnivorous species existed in such numbers at the time of the first settlement of the country by Europeans that their presence was a great check upon the rearing of stock, and even a source of danger to human life. Hence, naturally, an exterminating warfare was speedily begun upon them, which was stimulated by the offer of rewards by the